Radiometric Performance of the VIMS (Visible and Infrared Mapping Spectrometer) IR Channel on the Cassini Mission

C. A. Hibbitts and T. B. McCord, Hawaii Inst. of Geophys. and Planetology, U. Hawaii, Honolulu HI 96822; R. H. Brown, Lunar and Planetary Lab, Univ. of Arizona, Tucson, AZ 85719; R. Jauman and F. Trauthan, DLR, Institut für Plaentenerkundung, Rudower Chaussee 5, 12489, Berlin, Germany; A. Coradina, IAS (CNR) - Planetologia, viale dell' Universita 11, 00185 Roma, Italy; B. J. Buratti, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109; V. Formisano and G. C. Bellucci, Istituto di Fisica dello Spazio Interplanetario CNR (IFSI), via Galilei, c.p. 27, 00044 Frascati, Italy

The Cassini Mission, to be launched in November of this year, will carry a Visible/Infrared Mapping Spectrometer (VIMS) to Saturn to observe the planet, its moons, and rings during its four year mission beginning in June, 2004. Titan, Rhea, Dione, Iapetus, and Enceladus will be imaged by VIMS with up to about 1km resolution. The instrument consists of a visual and an infrared channel, having separate foreoptics but common electronics. The infrared channel utilizes a linear array of 352 InSb detectors measuring from 0.86 µm to 5.1 µm with a 10 to 20 nm bandwidth. There are 7 integration times (9, 16, 36, 76, 156, 316, and 636 ms), two gain states, and two bias settings. A 12-bit, analog-digital encoder (ADC) converts the analog signal to 0 to 4095 data numbers (DN). Calculation of the sensitivity (in Photon/DN or $Wm^{-2}Sr^{-1} nm^{-1}DN^{-1}$) of each detector is a primary goal of the radiometric calibration. Additional goals are to determine detector response with integration time and the exact effects of gain state and bias changes. Complete and concise calibration of this instrument before launch is required to ensure experiment success.

Radiometric calibration was performed in two sessions during January and July, 1996. The entire instrument was housed and cooled in a vacuum chamber at the Jet Propulsion Laboratory while the light sources, integration spheres, and collimator were located outside the chamber. The instrument temperature was set at 76, 66, and 59K for the January calibration. A tungsten lamp and a globar provided calibrated radiation in the spectral range of 0.7 to 2.5 µm and 2.5 - 5.2 µm, respectively. Eight light levels and seven integration times were used. During the July calibration, the array was maintained at 60 to 61K, the light sources were reduced to 10% and 50% of full illumination, and only the four shortest integration times were used. Data collected consisted of signal (source on) and dark (instrument shutter closed) interleaved. Sixteen repetitions of signal and dark for each specific setting were made in order to better facilitate statistical analysis. The lower signal levels prevented saturation of the analog-digital encoder at longer wavelengths, while the higher light levels and integration times ensured adequate signal at shorter wavelengths.

The total flux of photons detected is a combination of source, background, and dark signals. A 10 DN pedestal is added electronically to prevent zero or negative DN signals. A measurement of dark current (Figure 1) is obtained by turning off the source and closing the instrument's internal shutter. Background signal is obtained by turning the source off but otherwise operating the equipment as if taking measurements of the calibrated source. All calculations of gain state and bias ratios are done with the background present in the signal but after subtracting the 10 DN pedestal and the dark signal (Figure 2). Calculation of the overall instrument sensitivity requires precise subtraction of the background component from the total signal. Therefore, multiple measurements of background were taken before and after each aperture or source change.

Linearity of the instrument response with integration time, until ADC saturation occurs, is within system noise (Figure 3). The dark signal exhibits a standard deviation of 0.5 DN and 1.0 DN for gain states 1 and 2 respectively. The gain state ratio (G2/G1) is 2.20 +/- 0.01. There are low-sensitivity pixels at 1.62 and 3.81 µm. The standard deviation of signal minus dark is 0.1% to 0.5% and varies directly with source intensity. Overall instrument sensitivity is wavelength-dependent and varies between 10^4 and 10^5 photons/DN.

Radiometric Performance of Cassini VIMS; C. A. Hibbitts *et al.*

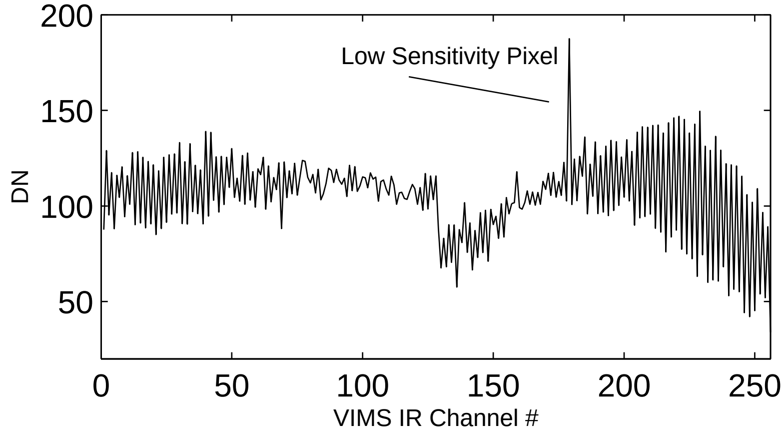

FIGURE 1

A characteristic dark signal at gain state 1, bias 1, and 9ms integration time. The oscillation of the dark signal is due to the use of different muliplexers for alternate channels.

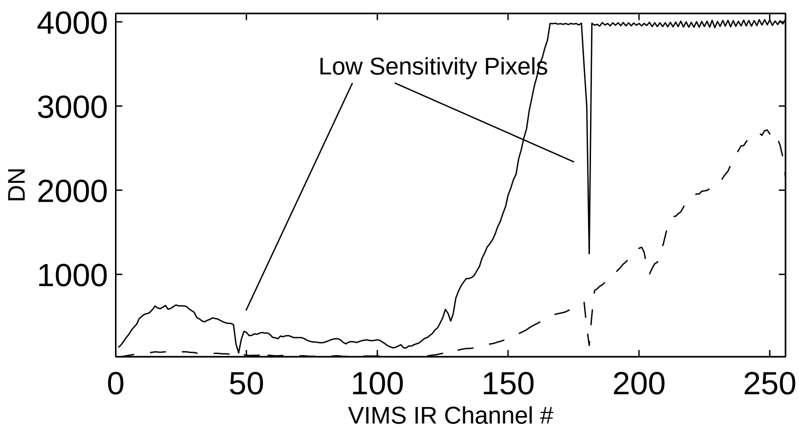

FIGURE 2

Signal minus dark but including background, for the tungsten source at 50% of full illumination, gain state 1, bias 1. The solid line is 76 ms integration time, the dashed line is 9 ms.

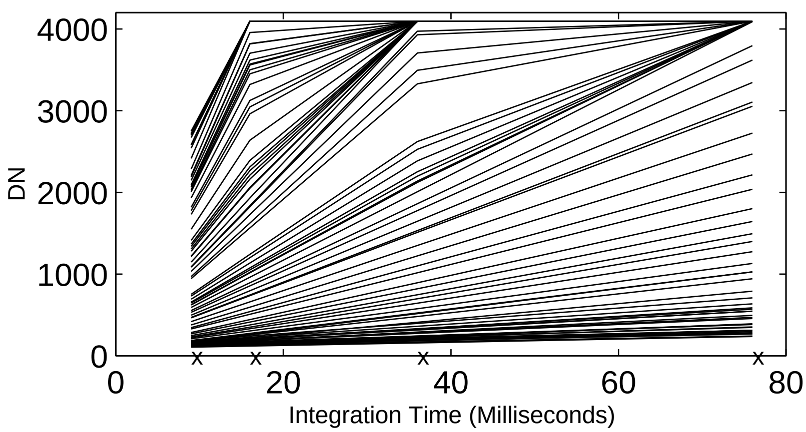

FIGURE 3

Linearity of detector responce for signal minus the 10 DN pedestal and at the four shortest integration times. The x's mark the integration times.